magnetic thickness) to 0.12 memu/cm^2 (equivalent to 15 Å in Ni-Fe magnetic thickness). If the desired full *in-situ* oxidization is attained, the Al-O film in contact with the Ni-Fe film protects the Ni-Fe film from oxygen penetration, thus maintaining the entire magnetic moment of the Ni-Fe film at 0.16 memu/cm^2 (equivalent to 20 Å in Ni-Fe magnetic thickness).

The present invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative and not restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes which come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. A spin-valve sensor disposed between gap layers, comprising:

an antiferromagnetic pinning layer;

a pinned layer disposed to one side of the antiferromagnetic pinning layer;

a sensing layer;

a spacer layer disposed between the pinned layer and the sensing layer and

a gap layer disposed to one side of the antiferromagnetic pinning layer, the gap layer comprising a plurality of oxidized metallic films.

2. The spin-valve sensor of claim 1, wherein the gap layer comprises a first gap layer disposed to one side of the antiferromagnetic pinning layer and further comprising a second gap layer disposed to one side of the sensing layer; the first and second gap layers comprising a plurality of oxidized metallic films.

3. The spin-valve sensor of claim 1, wherein the gap layer is formed of a

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plurality of *in-situ* oxidized metallic films.

4. The spin-valve sensor of claim 2, wherein at least one of the first gap layer and the second gap layer is formed of an *in*-situ oxidized metallic film.

5. The spin-valve sensor of claim 2, wherein the first gap layer and the second gap layer are each formed of a plurality of *in-situ* oxidized metallic films.

6. The spin-valve sensor of claim 2, wherein the first gap layer and the second gap layer are each formed of a plurality of *in-situ* oxidized Al metallic films.

7. The spin-valve sensor of claim 2, wherein the plurality of oxidizedmetallic films has a cumulative thickness in a range of between about 50 Å and about 200 Å.

8. The spin-valve sensor of claim 2, wherein the plurality of oxidized metallic films has a cumulative thickness in a range of between about 50 Å and about 200 Å.

9. The spin-valve sensor of claim 2, wherein each of the plurality of films has a cumulative thickness of about 100 Å.

10. The spin-valve sensor of claim 1, further a plurality of seed layers disposed to one side of the antiferromagnetic pinning layer; the seed layers comprising an Al_2O_3 film, a Ni-Cr-Fe film and a Ni-Fe film; the antiferromagnetic pinning layer formed of a Pt-Mn film; the pinned layers formed of a Co-Fe film, Ru film, and a Co-Fe film; the spacer layer formed of an oxygen-doped, *in-situ* oxidized Cu film; the sensing layer

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formed of a Co-Fe film and a Ni-Fe film, and a cap layer formed of an *in-situ* oxidized metallic film.

11. The spin-valve sensor of claim 10, further comprising a partially oxidized cap layer adjacent to the sensing layer.

12. A disk drive system comprising:

a magnetic recording disk;

a spin-valve sensor for reading data recorded on the magnetic recording disk, the spin-valve sensor comprising:

an antiferromagnetic pinning layer;

pinned layers formed disposed to the antiferromagnetic pinning layer, the magnetizations of the pinned layers substantially fixed by the antiferromagnetic pinning layer;

a sensing layer formed of ferromagnetic films adjacent to the pinned layers, the sensing layers configured to have an electrical resistance that changes in response to changes in magnetic flux through the sensing layer; and

a cap layer disposed to one side of the sensing layers, the cap layer formed of a partially *in-situ* oxidized metallic film having a thickness in a range of between about 5 and about 15 Å;

a first gap layer disposed to one side of the antiferromagnetic pinning layer, the first gap layer comprising a plurality of oxidized metallic films;

a second gap layer disposed to the cap layer, the second gap layer comprising a plurality of oxidized metallic films;

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an actuator for moving a read/write head comprising the spin-valve sensor across the magnetic recording disk in order for the spin-valve sensor to access different magnetically recorded data on the magnetic recording disk; and

a detector electrically coupled to the spin-valve sensor and configured to detect changes in resistance of the spin-valve sensor caused by rotation of the magnetization of the sensing layers relative to the fixed magnetizations of the pinned layers in response to changing magnetic fields induced by the magnetically recorded data.

13. A method of fabricating a spin-valve sensor, the method comprising:

forming an antiferromagnetic pinning layer;

forming pinned layers to one side of the antiferromagnetic pinning layer;

forming sensing layers;

forming a spacer layer disposed between the pinned layers and the sensing layers; and

forming a cap layer disposed to one side of the sensing layers by deposition and *in-situ* oxidation of a metallic film.

14. The method of claim 13, further comprising forming first and second gap layers, the forming first and second gap layers comprising depositing a metallic film and *in-situ* oxidizing the metallic film.

15. The method of claim 13, further comprising forming first and second gap layers, the forming first and second gap layers comprising forming a plurality of oxidized metallic films.

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16. The method of claim 15, wherein forming a plurality of oxidized metallic films comprises forming a plurality of *in-situ* oxidized aluminum films, each having a thickness in a range of between about 5 and about 15 Å.

17. The method of claim 13, wherein the deposition and *in-situ* oxidation of the metallic film comprises depositing the metallic film in a vacuum in a deposition module and transferring the metallic film to an oxidation module also in a vacuum and introducing an oxygen gas to the metallic film in the oxidation module in a controlled environment.

18. The method of claim 17, wherein depositing a metallic film comprises depositing an Al film.

19. The method of claim 17, wherein the deposition and *in-situ* oxidation of the metallic film comprises DC magnetron sputtering and *in-situ* oxidation for a time in a range of between about 1 and about 100 minutes in an oxygen gas with a pressure in a range of between about 0.1 and about 10 Torr.

20. The method of claim 17, wherein introducing the oxygen gas comprises introducing the oxygen gas with a pressure in a range of between about 0.5 and 5 Torr.

21. The method of claim 17, wherein introducing the oxygen gas comprises introducing the oxygen gas with a pressure in a range of between about 1 Torr and about 3 Torr.

22. The method of claim 17, wherein introducing the oxygen gas

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comprises introducing the oxygen gas with a pressure of about 2 Torr.

23. The method of claim 17, wherein introducing the oxygen gas comprises introducing the oxygen gas for a period in a range of between about 4 and about 12 minutes.

24. The method of claim 17, wherein introducing the oxygen gas comprises introducing the oxygen gas for a period in a range of between about 6 minutes and about 10 minutes.

25. The method of claim 17, wherein introducing the oxygen gas comprises introducing the oxygen gas for a period of about 8 minutes.

26. The method of claim 17, wherein introducing the oxygen gas is conducted at a temperature of approximately ambient room temperature.

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